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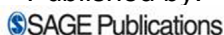
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The Evolution of Intra-Organizational Trust Networks

The Case of a German Paper Factory: An Empirical Test of Six Trust Mechanisms

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abstract: Based on the distinction between expressive and instrumental motives, six theoretical mechanisms for the formation of trust relationships are elaborated and empirically tested. When expressive motives drive tie formation, individuals primarily attach emotional value to social relationships. Three mechanisms have been tested: the homophily, the balancing, and the gossiping effect. When instrumental, control-related, motives drive tie formation, actors strategically establish relationships because of their potential use for the realization of material benefits or the avoidance of material losses. Again, three mechanisms have been tested: the signalling, the sharing group and the structural hole effect. Longitudinal data come from a sociometric panel study of 17 members of the management team of a German paper factory. Actor-oriented statistical modelling shows that all effects significantly affect trust formation separately. In a simultaneous test incorporating all six mechanisms, the pattern of structural holes turns out to be the major predictor of network evolution. The implications of structural hole theory for modelling the evolution of intra-organizational networks are discussed.

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Introduction

The past decade has witnessed an increasing awareness of the importance of trust for the functioning of teams and organizations (Kramer and Tyler, 1996; Dirks and Ferrin, 2001; Lane and Bachmann, 2001; Nooteboom and Six, 2003; Brass et al., 2004; for a review, see Kramer, 1999); trust is often shown to be a substitute for more costly monitoring devices (Chiles and McMakin, 1996; Creed and Miles, 1996; Das and Teng, 1998). Triggered by the mounting empirical evidence on the effect of intra-organizational trust on organizational outcomes (e.g. McAllister, 1995; Nooteboom et al., 1997; Gould-Williams, 2003; Langfred, 2004; Reagans et al., 2004), more and more organization scholars urge investigation of the antecedents and determinants of intra-organizational trust (Costa et al., 2001; Blunsdon and Reed, 2003; Bijlsma-Frankema and van de Bunt, 2003; Morrow et al., 2004; Spector and Jones, 2004), as well as the trajectory of its emergence and decline (Lewicki and Bunker, 1996; Jones and George, 1998). This literature has identified a large variety of factors and mechanisms that contribute to the dynamics of trust in organizations, ranging from individual attributes of team members and leaders (e.g. tenure), characteristics of the work environment (e.g. task interdependence) and the organizational context (e.g. organizational climate). Although the trust literature seems to be differentiated, researchers across disciplines agree that trust is an interpersonal (i.e. dyadic) concept (for a review, see Rousseau et al., 1998). Within the network tradition trust is explicitly conceptualized as an interpersonal relationship, which in general is embedded in triadic, and even more complex configurations of relations (see, among others, Simmel, 1950; Granovetter, 1985; Burt, 1992; Krackhardt, 1999). Furthermore, network research on trust has also shown that it affects organizational performance and intra-organizational dynamics (for reviews, see Krackhardt and Brass, 1994; Flap et al., 1998).

However, though considerable progress has been made with regard to the formal modelling of social network dynamics (Snijders, 2005), still very little seems to be known about the emergence and evolution of interpersonal trust networks in organizations. To a large degree, this is simply because of a lack of longitudinal intra-organizational trust network studies. Furthermore, very little cross-fertilization has taken place so far between organizational research on the antecedents of trust on the one hand, and network research on the evolution of social networks (not

necessarily trust networks) on the other hand (Zeggelink, 1993, 1994, 1995; Zeggelink et al., 1996; van de Bunt, 1999; van de Bunt et al., 1999; Wittek, 1999, 2001; Snijders and Baerveldt, 2003). The result of this separation is that each of the two literatures seems to rely on a different set of theoretical mechanisms that are invoked to explain the evolution of interpersonal (trust) relationships. Whereas organization researchers mostly emphasize characteristics related to work and the control of organizations, network scholars focus on factors that are strongly related to the social structure itself. In this article, about trust relations in a German paper factory, we want to make a first step in bridging this gap, by comparing several acclaimed, though to a certain degree competing, theoretical insights in interpersonal intra-organizational trust dynamics.

Following Dasgupta (1988), Camerer and Weigelt (1988), Coleman (1990), Kreps (1990) and Hardin (1992, 2002), we consider trust a *choice* behaviour.¹ More specifically, we are interested in modelling the evolution of trust *relationships*, i.e. relational choices between two actors. According to Coleman (1990), this implies that ego's choice to trust another actor can either be reciprocated by alter, or cannot be reciprocated. Similarly, ego may withdraw a trust choice in case alter ignores or even abuses ego's trust. Finally, in between ego's choice to trust alter and alter's response there is a time lag. In other words, alter is supposed to, or is allowed to, take his or her time before making his decision. Although this view upon trust is often used in cross-sectional survey (network) studies, this notion of trust, however, can only be substantiated by means of longitudinal data on trust networks.

The article is structured as follows. In the following section, we sketch the theoretical background and derive empirically testable hypotheses on the evolution of intra-organizational trust relations. We then introduce the research site, present the research design and the operationalizations of the main concepts. In order to get detailed information about each model *separately*, we discuss the results of each consecutive trust model, before allowing all models to compete with each other in our search for the most parsimonious collection of parameters in order to explain the development of the trust network. Since the analyses are based on a single case, we conclude with only a tentative discussion of our findings for research on intra-organizational trust networks.

Theoretical Background

In what follows, we focus on six different theoretical mechanisms about the formation of trust as they have been put forward in the literature. They can be loosely grouped into two categories, depending on the assumed motivational force underlying the initiation of a trust

relationship. Here, we build on the well-established distinction between expressive and instrumental motives for relationship formation (among others, Lincoln and Miller, 1979; Ibarra, 1992). Expressive motives are associated with the idea that humans attach emotional value to social relationships. The formation of ties is therefore primarily guided by their contribution to the social well-being of the individual, in terms of affection or the confirmation of belongingness (i.e. 'we-ness') needs or identities. Seen from this perspective, tie formation and dissolution occurs independently from the potential instrumental value or material costs following from the relationship.

Instrumental motives see trust relations as the result of strategic interaction and the deliberate effort of individual actors to control their environment in order to improve their personal well-being. In organizational settings, instrumental motives are realized through formal or informal control. In this perspective, the formation of trust relationships is primarily guided by their potential use for the realization of material benefits or the avoidance of material losses.

With the recent progress in the development of an action theoretic foundation for social network analysis (Burt, 1982; Coleman, 1990; Lin, 2001) and the advances in the field of actor-oriented statistical techniques for dynamic network modelling (Snijders, 1995, 1996, 2001, 2005; van de Bunt, 1999; van de Bunt et al., 1999), new approaches have become available to model the evolution of intra-organizational trust networks, taking into account expressive and instrumental motivations either separately or simultaneously. Hence, the more general question to be addressed here: what is the relative explanatory power of theoretical trust mechanisms building on expressive and instrumental motives, respectively?

Expressive Motives and Network Evolution: Trust and Affection

Within the literature, three prominent theoretical mechanisms can be distinguished that build on expressive motives. We refer to them as the homophily effect, the balancing effect and the gossip effect.

The Homophily Effect. The homophily hypothesis is probably one of the oldest network mechanisms that has been put forward to explain interpersonal close ties (e.g. Festinger et al., 1950; Lazarsfeld and Merton, 1954; Blau, 1977). It states that the more characteristics ego and alter have in common, the more likely they will develop a close relationship. The underlying 'similarity-attraction' mechanism assumes that similarity breeds sympathy because 'for those with similar values, then ... social contact, because it is rewarding, will motivate them to seek further contact' (Lazarsfeld and Merton, 1954: 30).

This homophily principle has been shown to be a very strong interpersonal network mechanism in a wide diversity of contexts, e.g. neighbourhood, community, school, work, voluntary organizations and with regard to numerous types of informal relationships, e.g. friendship, advice, social support and trust. We refer to McPherson et al. (2001) for an extensive overview, which clearly shows that similarity is a driving force in the initiation, maintenance and strengthening of informal relationships. Further, Lazarsfeld and Merton (1954) make a distinction between two types of homophily: status homophily and value homophily. The former refers to similarity with respect to attributes such as sex, age, ethnicity, education and occupation, whereas the latter refers to values, attitudes and beliefs. In the present study, we follow this distinction within an organizational context. This leads to the following hypothesis:²

Hypothesis 1: The more ego and alter are similar regarding a number of *status*- and *value*-related characteristics, the stronger the tendency for ego to initiate an interpersonal trust relationship to alter.

The Balancing Effect. Closely related to the homophily hypothesis is cognitive consistency theory, although not exactly the same, also referred to as balance theory (Heider, 1946, 1958; Newcomb, 1961), which, later on, served as the starting point of dynamic network analysis (see, for instance, the work of Cartwright and Harary, 1956; Davis, 1963, 1967; Holland and Leinhardt, 1971, 1972; Hallinan, 1974; Johnsen, 1986; Hummell and Sodeur, 1990; see Doreian et al., 1999, for a brief history of balance theory through time). In short, dynamic balance theory states that: (1) an asymmetric relationship will either become a mutual relationship, or a null relationship (i.e. an asymmetric relationship is not a stable and long-lasting state); (2) friends of my friends will become my friends. Phrased differently, ego chooses alters having the same friends ego has. The idea underlying the balancing argument is that actors feel uncomfortable in social situations in which those with whom they have a positive relationship hold different opinions with regard to the likeability or trustworthiness of third parties. In order to reduce the resulting cognitive dissonance, they are likely to change their attachments to others in the network such that a balanced social structure is the result. The balance argument is formalized in the following hypothesis:³

Hypothesis 2: The more ego is in balance with alter regarding third actors, the stronger the tendency for ego to initiate an interpersonal trust relationship to alter.

The Gossip Effect. The balancing effect points towards the importance of third parties for the formation of ties and the subsequent evolution of

the network. More recently, a different view on the role of third parties for trust formation was introduced into the discussion by Burt and Knez (1996: 83), who argue that 'third-party gossip thus serves to reinforce existing relations, making ego and alter more certain of their trust (or distrust) in one another'. Similarly, Wittek and Wielers (1998) provided empirical evidence that gossip behaviour is more likely to occur in close relationships embedded in coalition structures, i.e. in-group ties that share the negative evaluation of specific out-group members. This perspective predicts that trust will be more likely to develop between gossipmongers. The mechanism underlying this gossip effect is based on the assumption that individuals use gossiping in order to create social solidarity and affection with specific others at the expense of negatively evaluated third parties. Gossiping reinforces the solidarity and affection between the gossipmonger and the recipient of the gossip. Furthermore, disclosing private and secret information about other people can increase the status of the gossipmonger. This results in the following hypothesis:

Hypothesis 3a: The more ego and alter are similar with respect to gossip behaviour, the stronger the tendency for ego to initiate an interpersonal trust relationship to alter.

Following Wittek and Wielers (1998) in their claim that gossipmongers try to maximize status by providing not generally known information ('hot gossip') about third persons to alter, we assume that ego can maximize his or her status even more by striving after trust relationships with popular colleagues (i.e. colleagues who are trusted by many other colleagues) in order to get hold of the latest gossips. This results in the next hypothesis:

Hypothesis 3b: The more ego can be characterized as a gossipmonger, the stronger the tendency for ego to initiate interpersonal trust relationships to popular alters.

Instrumental Motives and Network Evolution: Trust and Control

Within organizations, the need for control arises from the functional interdependencies between its members: where the behaviour of an employee or a work group has negative or positive repercussions for other employees or the firm, those affected by these actions have a regulatory interest to influence, monitor or sanction the actions of their fellow workers (Heckathorn, 1990). Social networks have been identified as an important factor in the governance of transactions between and in organizations (Granovetter, 1985; Uzzi, 1999; Buskens et al., 2003; Bijlsma-Frankema and Klein Woolthuis, 2005). From the point of view of this 'embeddedness perspective' on organizational control, interpersonal trust

relationships are modelled as a result of strategic and instrumental behaviour to manage contingencies arising from interdependencies and information asymmetries. We refer to the three major mechanisms of interpersonal trust formation that have been put forward within the instrumental view as the signalling, the sharing group and the structural hole effect, respectively.

The Signalling Effect. A key element that distinguishes formal organizations from 'natural' social settings is the existence of a formally legitimated authority structure and the resulting hierarchy of positions and responsibilities. As a consequence, the interventions of management need to be taken into consideration as a potential factor influencing the evolution of intra-organizational trust networks.

Management can use different strategies of formal control to prevent damage and stimulate intelligent effort of employees. Which strategies are most efficient depends on the type of organizational process and work flow patterns that have to be governed. Building on an idea by Jacobs (1981), two types of organizational settings can be distinguished, depending on the kind of damage potential that results from the functional interdependencies in the firm (Mühlau, 2000). First, in settings characterized by disruptive damage potential, an inherent quality of the task and work situation is that extra effort of an employee cannot lead to significant performance improvements for the organization, whereas negligence or shirking can have serious negative consequences. For example, in an automated production line producing a fixed number of low-complexity goods per hour, extra effort of the worker will not lead to an increase in productivity, whereas wrong interventions in the process by an operator can cause costly production delays. Second, productive damage potential is given in settings where workers' negligence will have serious negative consequences for the firm, but where at the same time extra effort will significantly improve organizational performance. For example, if the product in the previously mentioned production line example was more complex so that extra effort by the operators would lead to an increase of product quality and a reduction of scrap, the setting could be characterized as one with productive damage potential.

Scholars of organizational control have argued that firms confronted with a high level of productive damage potential are likely to use fundamentally different forms of control than firms confronted with a high level of disruptive damage potential. Where productive damage potential is salient, firms are likely to invoke a gift exchange mechanism (Akerlof, 1982; Lindenberg, 1988; Ferrin and Dirks, 2003) to elicit the goodwill and intelligent effort of their employees. The creation of reciprocal obligations has been identified as a strong tool for the ex ante prevention of

opportunistic behaviour also in organizational settings (Fox, 1974). It entails that management continuously and consistently signals its 'good' intentions to the worker by investments into workers that are costly for the firm and imply that the firm makes itself to some degree vulnerable, because whether or not the actions will produce a payoff is at the discretion of the worker. These kinds of actions can be seen as a gift by the worker. For example, payment of 'efficiency wages', investments in costly training programmes or the procurement of other kinds of benefits that exceed the market wage would all be indicators of this kind of signalling behaviour. Gift giving triggers a normative orientation of the worker, who will be inclined to reciprocate by high effort and the willingness not to damage the firm. Thus, from a signalling perspective (see Lindenberg, 2003; two empirical applications are also provided by Costa, 2003, and Wittek, 2003) one would expect that in organizational settings characterized by a high productive damage potential of workers, management would continuously make moves signalling that it trusts employees. In terms of interpersonal trust relations between managers and employees, this is likely to result in an asymmetric distribution of interpersonal trust in the manager-subordinate dyad, because management has a stronger incentive than subordinates to actively demonstrate that it can still be trusted.⁴ This leads to the following hypothesis:

Hypothesis 4: For superiors, the tendency to trust their direct subordinate is stronger than the tendency for subordinates to trust their direct superior.⁵

The Sharing Group Effect. The signalling effect specifies the gift exchange mechanism underlying the formation of trust relationships in vertical relationships characterized by different types of damage potential. A similar reasoning holds for horizontal relationships. Depending on the degree and type of functional (inter)dependence (Lindenberg, 1982; van der Vegt, 1998), one's peers can be a significant source of damage and/or advantage to oneself (Costa, 2003). Sharing group theory (Lindenberg, 1982) argues that the stronger the degree of functional interdependence between peers, the higher the need to be able to rely on each other's goodwill, particularly if the behaviour of the other party cannot be constantly monitored. This implies that sharing group members have to rely on each other, but also, that they are subject to the harmful or beneficial side-effects of each other's actions. In other words, they can, either purposively or not, exert negative and positive externalities on each other. Hence, in relationships in which actors are highly functionally interdependent, informal rules and solidarity norms will govern the exchanges between the actors, resulting in the emergence of an interpersonal trust relationship between the two. Note that this does not imply that

interdependence is symmetric: ego may be more dependent on alter than vice versa. As in the case of management confronted with high productive damage potential of its employees, an employee who is unilaterally dependent on a peer is likely to invest into the trust relationship with this peer in order to elicit the other's goodwill (for a detailed illustration of this process, see Crozier's [1964] famous description of the relationship between the operators and the maintenance workers in a cigarette factory).

Hypothesis 5: The more ego has to depend on alter in completing his or her tasks, the stronger the tendency for ego to initiate an interpersonal trust relationship to alter.

The Structural Hole Effect. Burt's (1992) widely acclaimed structural hole theory has also implications for the evolution of intra-organizational trust networks. A structural hole is the result of an actor being tied to at least two other actors who are not related to each other and/or are structurally equivalent. Burt argues that persons with many structural holes occupy a brokerage position that yields information and control benefits. They have access to more diverse information, and have the opportunity to filter, adjust and withdraw information for their own purpose. Burt argues further that having many structural holes strongly correlates with having many weak ties (i.e. ties of low relational intensity or closeness). Phrased differently, a strategic ego network consists of, in general, weak ties to persons who are not connected to each other. If ego wants to consolidate his or her strategic position within the network, he or she should not put effort into transforming weak ties into strong ones, or prevent weak ties from becoming strong, but optimize the network by establishing new relationships to actors providing access to new subsets of the network that ego could previously not reach via the existing network.

Burt has formalized his argument on several measures, both on the individual level, and on the dyadic level (although still from the perspective of the individual). Assuming that persons with many structural holes (i.e. who have an efficient network and face a low degree of dyadic constraint) are aware of their advantageous position, this leads to the following hypotheses:

Hypothesis 6a: The more efficient ego's network, the less active ego is in initiating interpersonal trust relationships with alters.

Hypothesis 6b: The less ego is constrained by his or her relationship with alter, the weaker the tendency for ego to initiate an interpersonal trust relationship with alter.

In sum, at least six key mechanisms explaining the evolution of interpersonal trust in organizations can be discerned in the available literature

on social network evolution and organizational control. Empirical studies so far have usually either dealt with a single mechanism only, or have simultaneously tested only a subset of them. To our knowledge, the six mechanisms for the evolution of interpersonal trust relations at work have not yet been put to test simultaneously, a task that is tackled in the following section.

Data and Method

Investigating the different mechanisms behind the evolution of intra-organizational trust relationships requires sociometric choice data. It also requires a setting in which some substantial change in the interpersonal trust ties has taken place. A data set that meets these criteria has been collected in the context of a network panel study carried out from late 1995 until mid-1997 in a German paper factory.

Data analysis is based on sociometric information on the 17 members of the 'extended' management team of the factory.⁶ The factory is situated in a village with 800 inhabitants in southern Germany. When fieldwork started in 1995, the organization had 170 employees and two paper machines. After being declared bankrupt in 1993, the company was taken over by a German multinational that decided to invest DM40 million on enlarging the site with a new production hall and a third paper machine. The latter was scheduled to be operative on 1 September 1995. During the observation period (February 1995–July 1997), these activities before the deadline of 1 September 1995 were the main focus at the factory.

The formal structure of the paper factory was substantially changed twice during the observation period. This means that it is necessary to distinguish between three phases, each with a different type of formal structure and pattern of functional interdependence. During the first phase, the managers had to cope with a double workload. Besides their normal job in the daily production process, they were now also responsible for the successful realization of the common project. Mutual interdependence between them and the necessity to coordinate and cooperate reached previously unknown heights. During this phase (1995), a clear group goal was present. With the successful completion of the project at the end of 1995, the common group goal disappeared, although the production department still formed a single entity. The allocation of responsibilities concerning the new paper machine was highly ambiguous. In the beginning of 1996, solving the new machine's implementation problems was, on the whole, considered to be a joint task. Finally, in 1997, the production department was split up into three semi-autonomous units.

Sociometric information on interpersonal trust was collected at four points in time, time = t_1 to time = t_4 . Information on interpersonal trust

for time = t_2 , t_3 and t_4 was used as the dependent variable. They cover the period from July 1996 to July 1997, when the major changes in the informal relations took place. Data on job satisfaction, trust in peers and trust in management were collected at two points in time, of which we used those that we measured at time = t_2 . The task dependency structure was measured at time = t_3 . Organizational members' attributes such as age, level of education and tenure (i.e. the number of years already employed in the organization) were measured at time = t_1 . The constraint-based measures (efficiency, dyadic constraint) are based on the communication network measured at time = t_2 . Finally, gossip behaviour was also measured at time = t_2 .

During the whole observation period, 17 members of the management team participated in the study. Five managers either left before time = t_2 , or joined the group at time = t_4 . The average age was 41 (SD = 10.2), the oldest person was 59, the youngest 28. On average they had been employed for about 13 years (SD = 12; minimum = 1, maximum = 41) in the paper factory. Almost 80 percent had a university degree (13 out of 17), the rest had attended higher vocational school.

Dependent Variable

The question on 'Interpersonal Trust' was introduced by the following text:

'We all feel closer to particular people than to others. By "close" we mean how much you trust somebody. For example, to whom you confide personal information. This can include both private and work-related issues. Please indicate for each colleague on the list which of the following descriptions best describes your relationship with this person.'

Respondents were asked to choose one of four categories: distant, neutral, close and very close. For the analysis the trust network has been dichotomized: ego either trusts alter or ego has at most a neutral relationship with alter.

Independent Variables

'Interpersonal Communication' was operationalized as follows:

'During the past three months, how frequently did you talk during work time to your colleagues? It doesn't matter what you were talking about or where the conversation took place. However, the conversation should have been more than the transmission of a simple message or a greeting.'

Respondents could choose from a set of six categories, from several times a day to never. In order to calculate the constraint measures, the communication network has also been dichotomized: ego talks to alter at least once a day, or ego talks to alter less than once a day.

Following Burt (1992), the communication network is used in order to calculate the structural hole measures, 'efficiency' and 'dyadic constraint'. Efficiency is, essentially, the number of alters minus the average degree of alters within the ego network, not counting ties to ego, divided by the number of alters in ego's network (Borgatti et al., 2002). This results in a figure higher than 0, and at most 1. Ego's efficiency is defined according to Burt's proposition about redundancy by cohesion: the higher the number of relationships between ego's alters, the more constrained ego's network (i.e. the lower the efficiency of ego's network). Dyadic constraint is the extent to which ego is constrained by each of its alters separately (for more details we refer to Burt, 1992).

'Task Dependencies' was operationalized in the following way:

'To do our jobs we often need to cooperate more with some persons than with others. By "cooperation" we mean those situations in which the contribution of a colleague is important for your own work. During the past three months, how important was for you personally cooperation with each of your colleagues?'

Respondents had to rate this importance on a scale from 0 (played no role) to 100 (was very important), later recoded into scores between 1 and 4.

The following individual attributes were used to determine status homophily: age (in years), tenure (in years) and level of education (dummy: 0 = university; 1 = higher vocational school). Furthermore, we used the hierarchical level in the organization: actors occupying similar positions in the social structure have to face similar opportunities and constraints. This makes their actions more predictable than the behaviour of people in different structural positions. Where other reliable cues about the trustworthiness of other actors are lacking, initiating and maintaining trust relationships to persons in similar structural positions can potentially solve the information problem (Wittek, 2001: 114). Based on the formal hierarchy, the following categorization has been constructed. It defines the *hierarchical level* at which ego operates: (1) the director of the paper factory, and those that are under the direct supervision of the director, *and* supervise others (within the management team); (2) those that are under the direct supervision of the director, but do not supervise others (within the management team); and (3) those that are two steps away from the director, and do not supervise others (within the management team). Value homophily is based on the following two individual attributes: trust in peers and trust in management. The measurements of *trust in peers* and *trust in management* are based on nine items. Trust in peers is measured by six items (Cronbach's alpha is .86), and trust in management is measured by three items (Cronbach's alpha is .87). The

two components explain 67 percent of the variance. The items are taken from Cook and Wall (1980) (see Table 1). For more details, we refer to Wittek (1999). Factor scores are used in the analyses.⁷

Finally, we use the *gossip behaviour* scale as it was developed by Wittek and Wielers (1998). It consists of two components, one representing positive gossip (i.e. speaking positively about the behaviour of an absent person), the other representing negative gossip (i.e. speaking negatively about the behaviour of an absent person). In this article, we use the negative gossip scale. It consists of six items (see Table 2).

Table 1 *Trust in Peers and Management (Continuous Scale from 'Fully Disagree' to 'Fully Agree')*

Trust in peers^a

- I can trust the people I work with to lend me a hand if I need it.
- If I got into difficulties at work I know my workmates would try and help me out.
- Most of my colleagues get on with their work even if supervisors are not around.
- Most of my workmates can be relied upon to do as they say they will do.
- I have full confidence in the skills of my colleagues.
- I can rely on my colleagues not to make my job difficult by careless work.

Trust in management^{b, c}

- Management can be trusted to make sensible decisions for the future.
- Management at work seems to do an efficient job.
- General management is sincere in its attempts to meet the team members' point of view.

^a Cronbach's alpha = .86.

^b Cronbach's alpha = .87.

^c Principal component analysis: in total both components explain 67 percent of the variance.

Table 2 *Gossip Behaviour (10-Point Scale, Ranging from 'Almost Never' to 'Almost Always')*

Gossip behaviour^a

- Criticizing uncooperative behaviour of an absent person.
- Criticizing a negative trait or feature of an absent person.
- Criticizing the passive behaviour of an absent person.
- Asking the opinion of others concerning a particular behaviour of an absent person.
- Saying that they felt treated badly by an absent person.
- Making fun of the behaviour of an absent person.

^a Principal component analysis: one component explains 67 percent of the variance (Cronbach's alpha = .90).

Actor-Oriented Modelling

The trust models are tested by means of actor-oriented statistical network models. These models are especially designed to model the evolution of networks through time, taking into account the network structure, individual attributes and dyadic co-variables. Momentarily these models are the only ones capable of dealing with such complex designs. The models are implemented, under the name of SIENA, in the software package StOCNET (for more information, see Snijders, 1995, 1996, 2001, 2005; Snijders and van Duijn, 1997; van de Bunt, 1999; van de Bunt et al., 1999; Snijders and Baerveldt, 2003; Snijders and Huisman, 2003).⁸ We used the following strategy. In order to show the results of each trust model separately, all six models are analysed one by one. Second, the three expressive models (i.e. the homophily model, the structural balance model and the gossip model) are analysed simultaneously, after which the three instrumental models (i.e. the signalling model, the sharing group model and the structural holes model) are also analysed simultaneously. The final model is then estimated including the significant parameters of the two sets of models. Finally, the concluding model consisting of the most parsimonious collection of trust parameters is studied more thoroughly.

Results

The trust networks are shown in Figure 1.

Table 3 presents several descriptive network statistics. They show, rather dramatically, the collapse of the trust network in between time = t_1 and time = t_2 . The density (i.e. the total number of relationships relative to the total number of possible relationships among 17 persons) decreases from 0.40 to 0.31. The degree of reciprocity (i.e. the total number of mutual relationships relative to the total number of asymmetric and mutual relationships) and the degree of transitivity (i.e. the total number of transitive triplets relative to the total number of triplets) drop from 0.76 to 0.47, and 0.11 to 0.05, respectively.⁹ As from time = t_2 , the trust network, albeit rather slowly, re-establishes itself. This is shown by the small increase of the density and the degree of reciprocity and transitivity. Next to the ethnographic observation that an organizational event disrupted the trust network (see Wittek, 1999), these statistics also suggest that, for now, we should not model the whole observation period, but focus on time = t_2 to time = t_4 .¹⁰

The Expressive Trust Models

Table 4 shows the results of the baseline model, which only consists of two rate parameters, λ_{23} and λ_{34} , a density parameter, δ , and the reciprocity effect.

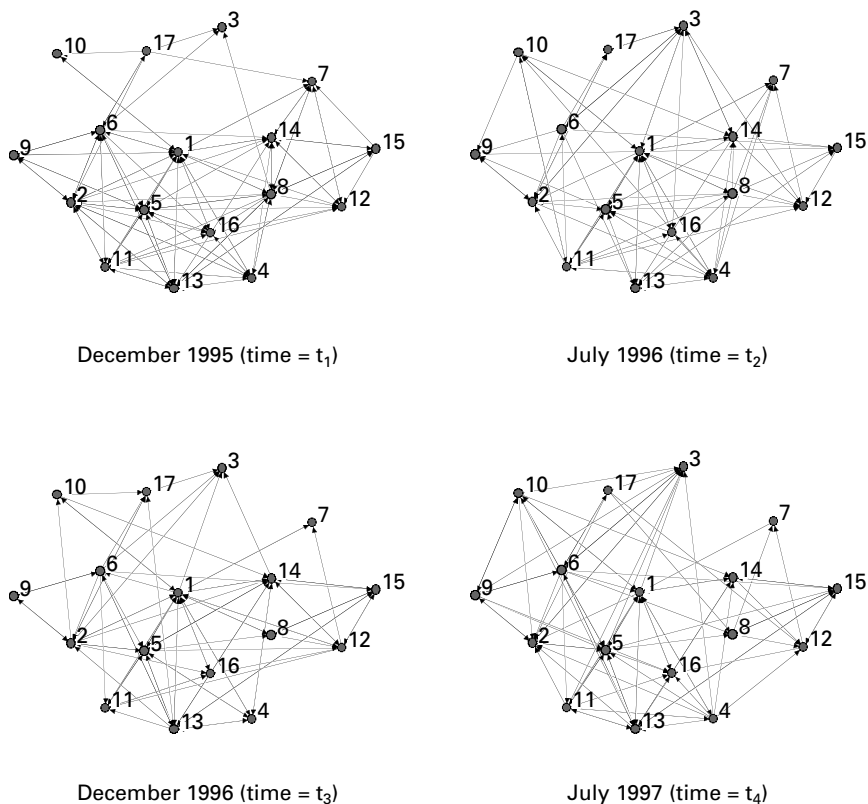


Figure 1 *The Trust Network at Four Points in Time*

A trust relationship from ego to alter is present if ego perceives the relationship to either be strong or very strong.

Table 3 *Trust Network Characteristics: Density, Degree of Reciprocity and the Degree of Transitivity*

Network characteristic	Time = t_1	Time = t_2	Time = t_3	Time = t_4
Density	0.40	0.31	0.31	0.33
Degree of reciprocity	0.76	0.47	0.70	0.55
Degree of transitivity	0.11	0.05	0.05	0.06

The rate parameters indicate that the estimated average number of changes per actor from time = t_2 to time = t_3 , and from time = t_3 to time = t_4 , are 5.43 and 4.86, respectively. The density effect ($\delta = -0.86$) has no substantial meaning: it simply corrects for the density of the network. The

Table 4 *Baseline Trust Model: Estimated Parameters of the Transition from a Neutral Trust Relationship to a Trust Relationship*

Parameters	Baseline model
λ_{23}	5.43 (0.91)**
λ_{34}	4.86 (0.86)**
δ	-0.86 (0.17)**
Reciprocity	1.15 (0.22)**

Standard errors within parentheses.

* $p < .05$; ** $p < .01$.

Estimations are based on 2000 simulation runs.

reciprocity effect shows that there is a strong tendency to establish reciprocal trust relationships ($t = 1.15/0.22 = 5.23$; $p < .001$).¹¹ As is shown in the coming models, the significance of this effect remains of approximately the same size, regardless of other included effects. Table 5 shows the results of the three expressive trust models, and the final expressive trust model.

The homophily test shows that, controlled for the other effects, the sizes of the last four parameters are very small. People show no preference for trust relationships with similar others regarding level of education, the

Table 5 *Homophily Model, Balance Model, Gossip Model and the Final Expressive Model: Estimated Parameters of the Transition from a Neutral Trust Relationship to a Trust Relationship*

Parameters	Homophily model ^a	Balance model	Gossip model	Final expressive model
λ_{23}	5.95 (1.02)**	5.36 (0.85)**	5.83 (0.97)**	5.85 (0.96)**
λ_{34}	5.35 (0.97)**	4.76 (0.84)**	5.23 (0.92)**	5.25 (0.96)**
δ	-0.85 (0.12)**	-0.76 (0.17)**	-0.87 (0.13)**	-0.79 (0.15)**
Reciprocity	1.07 (0.20)**	1.13 (0.22)**	1.17 (0.21)**	1.07 (0.21)**
Tenure (in years)	-0.63 (0.35)*			
Age (in years)	0.90 (0.40)*			
Level of education	-0.03 (0.18)			
Hierarchical level	0.05 (0.36)			
Trust in peers	0.12 (0.45)			
Trust in management	-0.14 (0.34)			
Structural balance		0.98 (0.49)*		0.79 (0.48)*
Gossip sim.			0.05 (0.39)	
Gossip \times pop. alter			1.82 (0.86)*	1.69 (0.82)*

Standard errors within parentheses.

* $p < .05$; ** $p < .01$.

Estimations are based on 2000 simulation runs. All models include the baseline model.

^a Since sex is a constant (all respondents are men), it is not part of the status homophily model.

degree of trust put in peers and management and position in the formal hierarchy. The only two parameters that are statistically significant are the status attributes tenure and age. The age effect points into the direction predicted by the homophily hypothesis ($t = 0.90/0.40 = 2.25; p < .05$). Thus, people have a preference to initiate interpersonal trust relations to alters of the same age. The tenure effect, however, is in the opposite direction as predicted by the homophily hypothesis ($t = -0.63/0.35 = 1.80; p < .05$). It seems that, controlled for the other effects, the evolution of the trust network in the paper factory is a function of tenure dissimilarity. In sum, we did not find much support for either the status homophily or the value homophily hypothesis.

The balancing model incorporates the strict network balance parameter as discussed in a previous section. As expected, the balance effect is positive, and statistically significant ($t = 0.98/0.49 = 2.00; p < .05$). This means that actors strive after balance in their trust networks: in case both ego and alter (do not) trust a third party, ego puts (no) trust in alter. The findings thus support Hypothesis 2.

Table 5 also presents the gossip model. It demonstrates that gossip-mongers show, as predicted in Hypothesis 3b, the tendency to initiate trust relationships with popular alters within the trust network (i.e. receive trust choices by many other actors) ($t = 1.82/0.86 = 2.12; p < .05$). We did not find any proof for Hypothesis 3a: there seems to be no gossip similarity effect.

The final expressive model is tested by means of a kind of backward stepwise regression procedure. Initially, all significant effects (detected in the three separate models) are part of the model. After estimation of the model, the most non-significant effect (if any) is left out. If two effects are of approximately the same most insignificant size, two models have been estimated. This procedure is carried out several times. The final expressive model shows that the two homophily effects, age similarity and tenure dissimilarity, are not significant anymore. The remaining effects (i.e. structural balance, and gossip \times popularity alter) remain significant, although the significance of both effects has become somewhat smaller. In other words, the evolution of trust is a function of the preference for reciprocal trust relationships ($t = 1.07/0.21 = 5.10; p < .001$), that are structurally balanced ($t = 0.79/0.48 = 1.65; p < .05$). Furthermore, the more one's behaviour can be characterized as a gossipmonger, the stronger the tendency to get engaged in trust relationships with popular alters ($t = 1.69/0.82 = 2.06; p < .05$).

The Instrumental Trust Models

Table 6 shows the results of the three instrumental models: the signalling model, the structural holes model and the sharing group model.

Table 6 *The Instrumental Models: Estimated Parameters of the Transition from at Most a Neutral Relationship to at Least a Strong Trust Relationship*

Parameters	Signalling model	Sharing group model	Structural holes model	Final instrumental model
λ_{23}	5.28 (0.94)**	5.90 (1.03)**	5.33 (0.85)**	4.77 (0.78)**
λ_{34}	4.64 (0.91)**	5.61 (1.11)**	5.17 (0.95)**	4.68 (0.91)**
δ	-1.22 (0.56)**	-0.20 (0.33)	-1.00 (0.19)**	-0.91 (0.18)**
Reciprocity	1.05 (0.22)**	1.03 (0.22)**	1.14 (0.25)**	1.08 (0.25)**
Sup. \rightarrow sub.	1.23 (0.52)**			
Task dependency		0.92 (0.37)**		
Dyadic constraint			1.09 (0.22)**	1.17 (0.23)**
Efficiency ego			3.44 (1.39)**	3.84 (1.77)**

Standard errors within parentheses.

* $p < .05$; ** $p < .01$.

Estimations are based on 2000 simulation runs. All models include the baseline model.

The signalling model shows that, controlled for the reciprocity effect, superiors have the tendency to put trust in their subordinates ($t = 1.23/0.52 = 2.37$; $p < .01$), thereby supporting Hypothesis 4. The sharing group model tests whether the task dependency structure influences the trust structure. The results show that the more ego is dependent on alter in doing his or her work (i.e. the more ego is dependent on alter in carrying out his or her daily tasks, from the perspective of ego), the more ego puts trust in alter ($t = 0.92/0.37 = 2.49$; $p < .01$). This finding corroborates Hypothesis 5.

The results based on the structural holes model show a positive and significant main effect of network efficiency on interpersonal trust. This implies that the more efficient ego's network, the *more* he or she strives to initiate interpersonal trust relationships ($t = 3.44/1.39 = 2.47$; $p < .01$). This finding in fact contradicts Hypothesis 6a, according to which the tendency to initiate new trust relationships should decrease the more efficient the network of an actor is. The sign of the dyadic constraint effect is highly significant and points to the expected direction ($t = 1.09/0.22 = 4.95$; $p < .001$), thereby confirming Hypothesis 6b. The less ego is dyadically constrained by alter, the less likely it is that ego will initiate a trust relation to alter: a loosely constrained ego shows the tendency to not transform his or her weak tie (i.e. communication) into a strong tie (i.e. communication *and* trust), and might even weaken his or her relationship. Those who are highly constrained via their relationship with alter, on the other hand, do not try to loosen their relationships, but even strengthen them. This suggests that the latter group strives after group closure.

Now that all instrumental trust models control models are tested separately, the final step is to integrate them into one statistical model in order to test which of the aforementioned control models is statistically the most significant. We applied the same procedure as used in determining the final homophily model. Table 6 shows that neither the signalling model nor the sharing group model are part of the final model. It is the structural holes explanation of the development of interpersonal trust that yields the best results (although not completely in line with our hypotheses; we come to that later). The final model also shows that controlling for the effects of the structural holes parameters, actors show a preference for reciprocated trust relationships. From this analysis it cannot be concluded, however, whether the upper management and/or the lower management belongs to either the efficient group or the inefficient group. Given the results of the signalling model, it could be that the members of upper management are not making their network more efficient, but rather strive for a reallocation of trust in both the lower-level and higher-level management in order to re-establish faith in both the upper management and the mother organization.

Instrumental and Expressive Models Compared

In Table 7 all models are integrated into one model, so that we can compare the relative explanatory power of the instrumental and the expressive models. As before, we used the same procedure as in determining the final expressive and instrumental trust model.

The final model shows that, again, structural hole theory seems to be the best predictor of the evolution of the trust network: individuals will not intensify their ties to persons who exert little structural constraint on them, and they will tend to initiate more trust relations the more efficient their network is. In sum, it seems that people strive after reciprocal trust relationships, and try to optimize their position within the network (i.e. search for the right mix of strong and weak ties).

As said, the final model only consists of structural holes effects. In order to get a more detailed picture of the effects in the final model, we add three new parameters. To compare the creation and termination of a tie to a constraining alter, we add what we call the 'breaking constraining tie' parameter. For reasons of clarification, suppose that the dyadic constraint effect of alter on ego is either 0 (no constraints imposed by alter on ego) or 1 (maximal constraints imposed by alter on ego). Table 7 then shows that, controlled for all other effects, the effect of creating a tie with a maximally constraining alter is 0.65, whereas the total effect of breaking a tie with such an alter is $-0.65 - 1.06 = -1.71$. In other words, it seems that actors are more eager to dissolve a trust relation with a constraining alter, than to initiate a trust relation with a constraining alter.

Table 7 *The Final Trust Model:^a Estimated Parameters of the Transition from at Most a Neutral Relationship to at Least a Strong Trust Relationship*

Parameters	Final trust model	Parameters	Elaborated final trust model
λ_{23}	5.68 (0.92)	λ_{23}	5.94 (1.02)**
λ_{34}	5.56 (1.02)	λ_{34}	5.95 (1.06)**
δ	-0.99 (0.14)	δ	-1.02 (0.15)**
Reciprocity	1.10 (0.22)	Reciprocity	1.23 (0.25)**
Dyadic constraint	1.07 (0.18)**	Dyadic constraint	0.65 (0.27)**
		Breaking constraining tie	-0.97 (0.58)*
Efficiency ego	3.13 (1.30)**	Efficiency similarity	-0.14 (0.61)
		Efficiency alter	-1.06 (0.92)
		Efficiency ego	3.60 (1.27)**

^a Except for the structural holes effects, all effects are non-significant.

Standard errors within parentheses.

* $p < .05$; ** $p < .01$.

Estimations are based on 2000 simulation runs. All models include the baseline model.

Table 8 *Network Efficiency: The Combined Estimated Effects Based on the Network Efficiency of Ego and Alter, and the Efficiency Similarity Effect*

	Minimally efficient network	Maximally efficient network
Minimally efficient network	-1.71	-2.63
Maximally efficient network	2.03	0.83

The remaining two parameters we added to the model are the 'efficiency similarity' effect (i.e. the tendency to get engaged in trust relationships with equally efficient alters) and the main effect of alter's efficiency. To interpret the three efficiency effects, we consider them simultaneously. Since efficiency is a continuous variable, we only present the four extremes. The resulting effects are presented in Table 8.

The joint effect of the efficiency-related parameters carefully worded suggests that actors with an inefficient network (i.e. low number of structural holes) neither trust alters with an efficient (an effect of -2.63) or (to a somewhat lesser degree) an inefficient network (-1.71). Actors with an efficient network trust alters with an inefficient network (2.03) and to a lesser degree alters with an efficient network (0.83). Put differently, actors with relatively many structural holes tend to increase their number of close relationships by initiating relationships with alters poor in structural holes, whereas actors relatively poor in structural holes seem to reduce their number of close relationships by terminating relationships with

alters rich in structural holes. We come back to the structural holes discussion in the concluding section.

Discussion and Conclusion

We distinguish two types of motives as a driving force behind network evolution: expressive and instrumental motives. Many models of evolution of intra-organizational networks were dominated by the idea that relational dynamics are driven first and foremost by expressive motives, with homophily considerations and the reduction of cognitive dissonance in affective triads providing the major mechanisms for relationship formation. Individual cognitions or attributes are the prime movers behind network evolution.

Others have suggested paying more attention to the possible instrumental motives behind the formation of interpersonal trust relationships in organizational settings. Their argument was that work settings generate specific constraints on the formation of social ties, which can counteract or neutralize the mechanisms underlying the evolution of networks in natural groups. Within this perspective, two different arguments were elaborated.

The first line of reasoning emphasizes the impact of formal organizational structures, in particular functional interdependencies on the one hand, and the formal control strategies associated with the hierarchical position of actors. Here, interpersonal trust is modelled as a function of formally defined patterns of interdependence and power. Individuals adapt to their formal work environment, they manage critical dependencies by embedding them into social exchanges. The dynamics of the informal network are contingent upon the formal organizational structure.

In the second line of instrumental reasoning, interpersonal trust relationships are the result of individual actors who actively try to optimize the benefits that their personal networks can generate – independently of the actor's position in the formal structure. In this perspective, individuals benefit from occupying brokerage positions, and therefore will try to change their network structure to increase their brokerage opportunities.

In sum, the three approaches emphasize either the importance of individual cognitions or attributes, the force of organizational contingencies, or the power of individual strategic motives as the major determinant of network evolution. From these approaches, we derived six effects divided in two groups: expressive and instrumental motives to trust.

Our results indicate that when tested separately, five of the six factors significantly affect the evolution of interpersonal trust. The only factor

that only partly produced significant results was the variables related to the homophily effect with respect to age, and tenure. The latter effect was even found to be in the opposite direction as predicted. These findings therefore support the idea that both expressive and instrumental motives drive the evolution of trust networks, and they indicate that also the mechanisms that have been introduced into the literature more recently and emphasize organizational contingencies or individual strategic behaviour are a fruitful and necessary extension of the literature on network evolution.

Our analysis showed further that when tested simultaneously, the six effects vary considerably in terms of their relative explanatory power. In the company under investigation, the major predictors for the initiation of interpersonal trust relationship between two actors are related to their structural holes. Thus, brokerage benefits seem to be a better predictor of network evolution in this management team than the mechanisms specified in the homophily, balancing, gossip, signalling or sharing explanations. That is, if this mechanism is taken into consideration, the other mechanisms lose their impact and become insignificant.

Though structural hole theory has generated a considerable body of insightful studies since its full elaboration more than a decade ago (Burt, 1992), until now not much attention has been paid to its potential implications for the evolution of networks. Both efficiency of the network and dyadic constraint turned out to be strong predictors for the initiation of interpersonal trust relationships – though having a highly efficient network in Burt's sense, contrary to our hypothesis, tends to increase an actor's efforts to initiate more additional ties. When viewed in the light of the positive effect of dyadic constraint on trust formation, one carefully formulated conclusion to be drawn from this finding might be that actors with a relatively efficient network and little dyadic constraint will initiate new trust relationships with those new parts of the network to which they do not yet have access. This interpretation would be in line with structural hole theory. It also highlights the entrepreneurial qualities Burt associates with individuals in broker positions (Burt et al., 1998).

A possible alternative explanation could be given by Simmelian tie theory, which partly opposes structural hole theory:

Burt's primary emphasis is on whether a person's ties to a set of alters are tied to each other; the more the alters are tied to each other, the more constraint is placed on ego. Simmelian tie theory, on the other hand, cares not only about such ties but whether a person is embedded in cliques; the more cliques one is embedded in, the more constrained the person is. (Krackhardt, 1999: 190)

Thus, due to their strategic position (i.e. a boundary spanning position crossing structural holes), actors with efficient networks are subject to

constraints as described in Simmelian tie theory; boundary spanners have to meet several, often different sets of group norms. Loosely interpreted, Simmelian tie theory would predict that such persons are constrained in their behaviour, and therefore will probably refrain from transforming their weak ties into strong ties. This is not different from what structural hole theory predicts. Highly inefficient actors (in Burt's terminology), on the other hand, only have to meet the norms of one group. They may stick to their own highly tied group with its specific norms and rules; peer pressure could keep group members from starting new trust relationships (see also Nooteboom, 2003) with outsiders. According to Simmelian tie theory, they will probably intensify relationships within their own group. This prediction partly differs from structural hole theory, which would predict that inefficient actors who are *aware* of their inefficient positions should optimize their positions by initializing relationships outside their own group. To see whether this alternative explanation is supported by the data, we carried out some additional analyses on the evolution of the trust network of the management team of the paper factory. The results (not shown) support Simmelian tie theory: the more cliques ego belongs to, the less likely it is that ego will initiate trust relationships to new alters, unless ego and alter are strongly tied to each other by both being member of the same cliques.

Before discussing the implications of these findings for future research, we want to indicate some methodological limitations of our study. First of all, the results are built upon one single case, the management team of a German paper factory, consisting of relatively few persons. Second, our operationalization of status and value homophily might have been based on suboptimal attributes, in the sense that they are not the main attributes to identify the homophily effect. Third, the task dependency structure is measured at time = t_3 . Although we have reasons to assume that this structure is relatively constant over time, at least during the period from time = t_2 to time = t_3 (we refer to the section about the paper factory for more details), we only have observational but no statistical proof that this is indeed the case. Fourth, gossip behaviour is not operationalized in terms of individual gossip behaviour, but on the perception of gossip within the organization. Although we treat this perception as a proxy for the manifestation of individual gossip behaviour, it is not precisely the same. Future studies could certainly benefit from a better measurement of gossip behaviour and the dependency structure. Finally, although actor-oriented models are the best yet available to model the evolution of social networks, it still lacks several important features; it is not yet possible to model changing dyadic co-variables, the construction of goodness of fit tests has only started recently and multiplexity problems cannot be tackled yet.

The findings have some interesting implications for the future study of the formation of intra-organizational trust networks. First, rather statically formulated hypotheses, such as the similarity hypotheses and the task dependency hypothesis, can easily be extended to explain the evolution of interpersonal trust networks. In general, our future goal is to define under which circumstances, which trust mechanism performs better, as either being a static, or a dynamic explanation of the formation of interpersonal trust. In particular, the differences between structural hole theory and Simmelian tie theory in relation to the evolution of intra-organizational trust networks should be investigated in far more detail. The conditions under which structural hole theory operates in favour of Simmelian tie theory, and vice versa, is a relatively unexplored area of research, and might shed more light on the trust problem. Second, although we treated all control mechanisms as being equally important, it could well be that specific characteristics of the organization under study should be incorporated into the analysis. Our future aim is to define the conditions under which either of the trust-control mechanisms should theoretically play a relatively more important role. Our finding that structural hole theory was the best predictor could for instance be because of the actual organization under study. Within the higher management of an organization, strategic choices might be more likely to occur than among blue-collar employees of some other organization. Third, as already mentioned in the section on the methodological drawbacks, attributes that define status and value homophily might be context dependent. Another future aim is to define under which conditions which individual attributes play a role, and, consequently, serve either as similarity or dissimilarity constituents of trust.

Notes

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1. See Kramer (1999) to see how trust as choice behaviour is positioned within the trust research tradition, and how it contrasts trust as a psychological state.
2. All hypotheses are expressed from the perspective of ego.
3. The reciprocity hypothesis is not unique for structural balance theory. Norms of reciprocity are universally accepted. Without sometimes even referring to the tendency to get engaged in mutual trust relationships, each of the discussed theoretical trust mechanisms implicitly assumes reciprocity. Therefore, the reciprocity effect is part of our baseline model (see the Results section).
4. See Den Hartog (2003) for a study on the trust relationship between supervisor and subordinates, conditional on the type of leadership employed by the supervisor.

5. Our operationalization of trust is in terms of confiding private and work-related information. Although it is often found that superiors do not talk about private matters with their subordinates, we assume that this does not hold in this specific case study about a management team.
6. Within the factory, a distinction is made between a 'core' and an 'extended' management team. The core of the management team consisted of the COO (chief operations officer), his or her assistant and the heads of the production, maintenance, logistics, personnel, controlling, and project departments (eight persons). The 'extended management team' also comprised junior engineers reporting to the department heads.
7. The present network study was part of a larger network research project in five organizations. Core questions were asked in all organizations. The factor analysis was performed on the data of all organizations (in total the sample size was approximately 200).
8. StOCNET can be downloaded from Snijders' homepage; at: stat.gamma.rug.nl/snijders
9. Because of the still numerous present trust relationships, Figure 1 does not show as clearly as Table 3 the collapse of the trust network in between time = t_1 and time = t_2 . Figures based on only the very strong trust relationships, would have shown this decrease.
10. For more details about density, reciprocity, transitivity and other common network characteristics we refer to Scott (1991), Wasserman and Faust (1994) and Degenne and Forsé (1999).
11. All parameters are tested one-sidedly.

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